## REMARKS

This paper is being presented in response to the non-final official action dated August 28, 2006, examining claims 1-19. Claims 20-23 have been withdrawn from further consideration in view of the restriction requirement imposed in the April 27, 2006, official action, made final in the current official action. According to the current official action, the pending claims 1-19 are allegedly anticipated by the disclosure found in *each of thirteen* different patent publications. Specifically, claims 1-19 have been rejected under 35 USC § 102(b) as being anticipated by each of five different patent publications. These claims also have been rejected under 35 USC § 102(e) by each of eight (other) different patent publications. All of the rejections are traversed, and reconsideration and withdrawal of the rejections are respectfully requested in view of the following remarks.

This paper is timely filed as it is accompanied by a petition under 37 CFR § 1.136(a) for an extension of time to file in the first month, and payment of the required extension fee.

### I. The 35 USC § 102 Rejections Are Traversed

Claims 1-19 have been rejected under 35 USC § 102(b) as being anticipated by each of the following five patent publications:

**(a)** U.S. Patent No. 5,256,209 (Chihara et al.);

**(b)** U.S. Patent No. 4,784,777 (Dellinger);

**(c)** U.S. Patent No. 4,169,068 (Harita et al.);

**(d)** U.S. Patent No. 6,730,644 (Ishikawa et al.); and,

**(e)** U.S. patent application publication No. 2002/0009674 (Nohara et al.).

*See* the Action at pp. 2-8 and 14-15. Claims 1-19 also have been rejected under 35 USC § 102(e) as being anticipated by each of the following eight publications:

**(f)** U.S. patent application publication No. 2004/0121615 (Kaneko et al.) published June 24, 2004, from an application filed October 9, 2003;

**(g)** U.S. Patent No. 6,887,654 (Lundy et al.) published May 3, 2005, from an application filed May 7, 2003;

**(h)** U.S. Patent No. 7,018,964 (Maeno et al.) published March 28, 2006, from an application filed June 18, 2002;

**(i)** U.S. patent application publication No. 2003/0152874 (Nakahara et al.) published August 14, 2003, from an application filed December 10, 2002;

**(j)** U.S. patent application publication No. 2004/0104196 (Nakamura et al.) published June 3, 2004, from an application filed August 21, 2003;

**(k)** U.S. patent application publication No. 2005/0009365 (Sugeta et al) published January 13, 2005, from an application filed October 24, 2003;

**(l)** U.S. patent application publication No. 2004/0106737 (Sugeta et al.) published June 3, 2004, from an application filed August 21, 2003; and,

**(m)** U.S. patent application publication No. 2004/0002437 (Wilson et al.) published January 1, 2004, from an application filed June 25, 2002.

*See* the Action at pp. 2-4, 9-14, and 15-19.

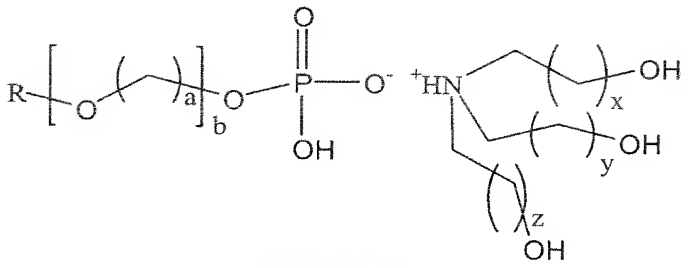
Each rejection is traversed. A complete response is set forth below.

### A. Proper Basis for a § 102 Rejection

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631 (Fed. Cir. 1987). Thus, a determination that a claim is anticipated under 35 USC § 102 involves two analytical steps. First, the U.S. Patent and Trademark Office (PTO) must interpret the claim language, where necessary, to ascertain its meaning and scope. In interpreting the claim language, the PTO is permitted to attribute to the claims only their broadest *reasonable* meaning as understood by persons having ordinary skill in the art, considered in view of the entire disclosure of the specification. *See In re Morris*, 127 F.3d 1048, 1054(Fed. Cir. 1997). Second, the PTO must compare the construed claim to a single prior art reference and set forth factual findings that "each and every limitation is found either expressly or inherently [disclosed] in [that] single prior art reference." *Celeritas Techs. Ltd. v. Rockwell Int'l Corp.*, 150 F.3d 1354, 1360(Fed. Cir. 1998). Additionally, "[t]he identical invention must be shown in as complete detail as is contained in the patent claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236 (Fed. Cir. 1989).

### B. The § 102 Rejections Are Traversed

Each of the pending claims recites the presence of a compound of Formula 1:




**Formula 1**

wherein

R is $C_2$-$C_{20}$ alkyl or $C_6$-$C_{25}$ alkyl aryl;

x, y and z individually are an integer ranging from 0 to 10;

a is 2 or 3; and

b is an integer ranging from 2 to 50.

The action asserts—without citation to any authority—that the Patent Office need not demonstrate a disclosure of Formula 1 to support a rejection under 35 USC § 102:

> The surfactant of claim 1 can be described in several ways. First the compound can be considered a phosphate a phosphate ester, or a phosphoric acid ester, an alkyl phosphate salt, an alkyl phosphoric acid salt, etc. Second the group found on the left can be described as a ethoxy group, an ethyoxylate, a propoxylated, an alkoxylated, an alkoxy group, etc. Finally, the group on the right of the formula can be described as a alkanolamines, ethanolamine, monoethanolamine, r an ammonium hydroxide (when x,y,z=0).
>
> As the surfactant is a salt, in other words a reaction of a negative anion, the phosphate, with a positive ion, the alkanolamines, *the examiner need not find the exact formula.* But would only be required to find the ethoxylated alkyl phosphoric acid in a solution with an alkanolamines. As the two charges are positive and negative, these two groups would inherently form the salt found in claim 1.

The Action at pp. 3-4 (emphasis added).

**1. The § 102(b) Rejections Are Traversed**

It is respectfully submitted that the pending claims are not anticipated by any of the cited publications:

**(a)** U.S. Patent No. 5,256,209 (Chihara et al.);

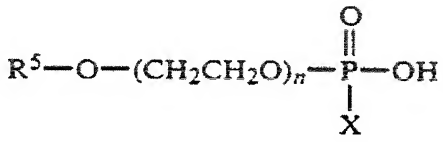
**(b)** U.S. Patent No. 4,784,777 (Dellinger);

**(c)** U.S. Patent No. 4,169,068 (Harita et al.);

**(d)** U.S. Patent No. 6,730,644 (Ishikawa et al.); and,

**(e)** U.S. patent application publication No. 2002/0009674 (Nohara et al.).

U.S. Patent No. 5,256,209 (Chihara et al.) discloses a cleaning agent for rosin-base solder flux removal, comprising a specific glycol ether compound, nonionic surfactant and phosphate anionic surfactant, wherein the phosphate anionic surfactant is represented by



wherein X is represented by

$$R^6O(CH_2CH_2O)_n—,$$

and wherein $R^6$ is triethanolamine.

Rosin-base fluxes are employed to accomplish the soldering. After soldering, a cleaning agent is used to selectively and completely remove only the flux. When the cleaning agent fails to completely remove the flux, the remaining flux adversely affects the soldering, undesirably resulting in circuit corrosion, and a reduction of electrical insulating properties on board surface. That is, when using a cleaning solution comprising the above three components (i.e., a specific glycol ether compound, nonionic surfactant and phosphate anionic surfactant), rosin-base fluxes can be selectively and completely removed. Particularly, when a specific glycol ether compound and nonionic surfactant are conjointly used as essential ingredients, the effect of Chihara et al. could be effectively accomplished. In contrast, however, rosin-base solder flux cannot be removed by water and a phosphate anionic surfactant as recited in the pending claims. Furthermore, if a glycol ether compound is used for cleaning a photoresist pattern in the present invention, a cleaning process for removing the glycol ether compound is additionally required. Because the flash point of glycol ether compound is about 70°C (see col. 5, lines 39-40), a succeeding process may be necessary. There is also no teaching or suggestion in the Chihara patent that the glycol ether is an optional ingredient. Accordingly, the Chihara patent does not anticipate the pending claims and, therefore, reconsideration and withdrawal of the § 102(b) rejection are respectfully requested.

U.S. Patent No. 4,784,777 (Dellinger) teaches a thick viscous liquid composition for restoring a printing blanket. The disclosed composition includes a sulfated fatty alcohol anionic surfactant, a sulfonated alkylaryl anionic surfactant, an organic phosphate ester surfactant, a nonionic surfactant or a water-soluble salt, an amphoteric surfactant other than an amphoteric organic phosphate ester surfactant. Dellinger teaches that a triethanolamine salt is used as the anionic surfactant and polyoxyethylene(4)decyl ether phosphate is used in a free acid form for the organic phosphate ester surfactant. Dellinger recites that particular blend of anionic surfactants, a phosphate ester surfactant, and either nonionic surfactant, or both an amphoteric surfactant and a water-soluble salt, in an aqueous-based solvent, provides a thick viscous liquid useful for permanently restoring a conventional printing blanket having an unmarred or unbroken elastomeric face but in need of restoring a conventional printing blanket. The Dellinger patent, however, does not disclose the identical invention in as complete detail as it is recited in the rejected, pending claims. *See Suzuki Motor Co.*, 868 F.2d at 1236 (stating that "[t]he identical invention must be shown in as complete detail as is contained in the patent claim"). Accordingly, the Dellinger patent does not anticipate the

pending claims and, therefore, reconsideration and withdrawal of the § 102(b) rejection are respectfully requested.

U.S. Patent No. 4,169,068 (Harita et al.) discloses a stripping composition that contains acid esters of phosphoric acid, $H_2O_2$, an organic solvent, and a polyhydric alcohol. A person having ordinary skill in the art would know that hydrogen peroxide and the organic solvent serve to *dissolve* the photoresist film to be removed. There is no teaching or suggestion in the Harita patent that these components are optional. Furthermore, the Harita patent does not disclose the identical invention in as complete detail as it is recited in the rejected, pending claims. *See Suzuki Motor Co.*, 868 F.2d at 1236 (stating that "[t]he identical invention must be shown in as complete detail as is contained in the patent claim"). Accordingly, the Harita patent does not anticipate the pending claims and, therefore, reconsideration and withdrawal of the § 102(b) rejection are respectfully requested.

U.S. Patent No. 6,730,644 (Ishikawa et al.) discloses a cleaning solution for removing particles and metallic impurities from a substrate surface without corroding metallic materials. The disclosed solution includes an organic acid compound and at least one material selected from the group consisting of dispersants and surfactants, and selectively a water-soluble alcohol. The Ishikawa patent teaches that a phosphate can be used as a dispersant, but fails to disclose the structure of salt-type surfactant as recited in the rejected, pending claims. Accordingly, the Ishikawa patent does not anticipate the pending claims and, therefore, reconsideration and withdrawal of the § 102(b) rejection are respectfully requested.

U.S. patent application publication No. 2002/0009674 (Nohara et al.) discloses a stripping composition that contains a nitrogen-containing organohydroxyl compound, alkylene glycol monoalkyl ether, sugar or sugar alcohol, a phosphorous-containing compound, and water. The nitrogen-containing organohydroxyl compound increases the photoresist-stripping speed. *See* ¶ [0015] of the Nohara publication. There is no teaching or suggestion in the Nohara publication that this compound is optional. Furthermore, the Nohara publication does not disclose the identical invention in as complete detail as it is recited in the rejected, pending claims. *See Suzuki Motor Co.*, 868 F.2d at 1236 (stating that "[t]he identical invention must be shown in as complete detail as is contained in the patent claim"). Accordingly, the Nohara publication does not anticipate the pending claims and, therefore, reconsideration and withdrawal of the § 102(b) rejection are respectfully requested.

Accordingly, reconsideration and withdrawal of the § 102(b) rejections are respectfully requested.

**2. The § 102(e) Rejections Are Traversed**

The present application was filed November 26, 2003, and claims priority under 35 USC § 119(a) to Korean patent application No. 2003-14796 filed March 10, 2003, and Korean

patent application No. 2003-22273 filed April 9, 2003. A verified English-language translation of Korean patent application No. 2003-14796 filed March 10, 2003, is appended hereto as Appendix "A." A verified English-language translation of Korean patent application No. 2003-22273 filed April 9, 2003, is appended hereto as Appendix "B." Based on these translations, it is clear that each of these applications provides written description support demonstrating the applicants' possession of the presently claimed subject matter as of each application's filing date. Specifically, the March 10, 2003, Korean application provides a disclosure of the compound of Formula 1, wherein *a* is 2, and the April 9, 2003, Korean application provides a disclosure of the compound of Formula 1, wherein *a* is 3. Consequently, none of the following publications may be applied to support a rejection under § 102(e), because the priority date(s) of the present application antedate the filing date of each applied publication:

> **(f)** U.S. patent application publication No. 2004/0121615 (Kaneko et al.) published June 24, 2004, from an application filed *October 9, 2003*;
>
> **(j)** U.S. patent application publication No. 2004/0104196 (Nakamura et al.) published June 3, 2004, from an application *filed August 21, 2003*;
>
> **(k)** U.S. patent application publication No. 2005/0009365 (Sugeta et al) published January 13, 2005, from an application *filed October 24, 2003*; and,
>
> **(l)** U.S. patent application publication No. 2004/0106737 (Sugeta et al.) published June 3, 2004, from an application *filed August 21, 2003*.

Accordingly, the § 102(e) rejections relative to each of the foregoing publications is traversed, and reconsideration and withdrawal of these rejections are respectfully requested.

It is respectfully submitted that the pending claims are not anticipated by the following publications:

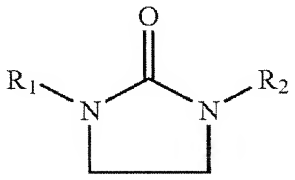
> **(g)** U.S. Patent No. 6,887,654 (Lundy et al.) published May 3, 2005, from an application filed May 7, 2003, which claims priority to a provisional application filed May 7, 2002;
>
> **(h)** U.S. Patent No. 7,018,964 (Maeno et al.) published March 28, 2006, from an application filed June 18, 2002;
>
> **(i)** U.S. patent application publication No. 2003/0152874 (Nakahara et al.) published August 14, 2003, from an application filed December 10, 2002;
>
> **(m)** U.S. patent application publication No. 2004/0002437 (Wilson et al.) published January 1, 2004, from an application filed June 25, 2002.

As described below, none of these publications discloses each an every feature recited in independent claim 1.

U.S. Patent No. 6,887,654 (Lundy et al.) discloses a composition for reducing or preventing residue and scum formation on a substrate surface. The disclosed composition contains an aromatic alkoxylate polyol in combination with a polyol or ether or ester of a polyol. As disclosed, a tristyrylphenol alkoxylate is used as the aromatic alkoxylate and forms a salt in combination with a phosphate and triethanolamine. However, because the pending claims recite a range for *b* of "from 2 to 50," the tristyrylphenol alkoxylate structure does not appear in the surfactant of the present invention. Accordingly, the Lundy patent does not anticipate the pending claims and, therefore, reconsideration and withdrawal of the § 102(e) rejection are respectfully requested.

U.S. Patent No. 7,018,964 (Maeno et al.) discloses a cleaning solution composition for removing solder fluxes used in the preparation of flip chip devices. The disclosed solution includes alkanolamine salts of a polyoxyalkylenephosphoric ester and the compound represented by Formula (A):

**Formula (A)**




If the compound represented by Formula (A) were used to clean a photoresist pattern, then a cleaning process for removing that compound should be performed to prevent the compound of Formula (A) from working as a particle and affecting the reliability of devices utilizing the pattern. There is no teaching or suggestion in the Maeno patent that the compound of Formula (A) is optional—quite to the contrary, it appears to be an essential component of the solution disclosed in the Maeno patent. Furthermore, the Maeno patent does not disclose the identical invention in as complete detail as it is recited in the rejected, pending claims. *See Suzuki Motor Co.*, 868 F.2d at 1236 (stating that "[t]he identical invention must be shown in as complete detail as is contained in the patent claim"). Accordingly, the Maeno patent does not anticipate the pending claims and, therefore, reconsideration and withdrawal of the § 102(e) rejection are respectfully requested.

U.S. patent application publication No. 2003/0152874 (Nakahara et al.) discloses a photoresist *stripping* composition, which removes all photoresist. The Nakahara publication does *not* disclose a photoresist *cleaning* solution, which would just rinse the photoresist without causing any damage on the already formed photoresist pattern. The composition disclosed in the Nakahara publication contains alkanolamine, amide or sulfoxide solvent, a

phosphorous-containing compound, oxycarboxylic acid, and water. A person having ordinary skill in the art would recognize that alkanolamine is contained in a photoresist remover composition to *strip* an organic substance, such as photoresist. There is no teaching or suggestion in the Nakahara publication that the alkanolamine is optional—quite to the contrary, it appears to be an essential component of the solution disclosed in the Nakahara publication. Furthermore, the Nakahara publication does not disclose the identical invention in as complete detail as it is recited in the rejected, pending claims. *See Suzuki Motor Co.*, 868 F.2d at 1236 (stating that "[t]he identical invention must be shown in as complete detail as is contained in the patent claim"). Accordingly, the Nakahara publication does not anticipate the pending claims and, therefore, reconsideration and withdrawal of the § 102(e) rejection are respectfully requested.

U.S. patent application publication No. 2004/0002437 (Wilson et al.) discloses a flushing solution for removing coatings, such as paints. The disclosed solution contains an organic solvent, a fatty acid salt, and an alkaline source as essential components, and further includes as an optional component, an aliphatic phosphate ester in combination with a buffering agent. The Wilson publication, however, fails to disclose a salt-type surfactant structure of the present invention. Accordingly, the Wilson publication does not anticipate the pending claims and, therefore, reconsideration and withdrawal of the § 102(e) rejection are respectfully requested.

## CONCLUSION

In view of the foregoing, reconsideration and withdrawal of the rejections, and allowance of all pending claims are respectfully requested.

Should the examiner wish to discuss the foregoing, or any matter of form or procedure in an effort to advance this application to allowance, the examiner is urged to contact the undersigned attorney.

Respectfully submitted,

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**December 27, 2006**

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## APPENDIX A

A verified English-language translation of Korean patent application No. 2003-14796 filed March 10, 2003.

**STATUTORY DECLARATION**

I, Hyun Soon KIM, a citizen of the Republic of Korea and a staff member of Bae, Kim & Lee IP Group, do hereby declare that:

1) I am conversant with the English and Korean languages and am a competent translator thereof;

2) To the best of my knowledge and belief, the following is a true and correct translation of the Priority Document (KR Patent Application No. 10-2003-0014796) filed on March 10, 2003.

Signed this 18th day of December 2006

Hyun Soon KIM

# KOREAN INTELLECTUAL PROPERTY OFFICE

This is to certify that the following application annexed hereto is a true copy from the records of the Korean Intellectual Property Office.

**Application Number: 10-2003-0014796**

**Date of Application: March 10, 2003**

**Applicant(s): Hynix Semiconductor Inc.**

**Dated October 6, 2003**

COMMISSIONER

**[Document Name]** Patent Application

**[Claim Division]** Patent

**[To]** The Commissioner of Korean Intellectual Property Office

**[Filing Date]** March 10, 2003

**[International Patent Classification]** H01L

**[Title of Invention]** Cleaning Solution for Photoresist and Method for Forming Pattern Using the Same

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**[Purport]** We file an application pursuant to Article 42 of the Korean Patent Law.

Patent Attorney Eui In HWANG
Patent Attorney Jung Hoon LEE

**[Official Fee]**

| | | |
|---|---|---|
| [Basic Fee] | 17 page(s) | 29,000 Won |
| [Additional Fee] | 0 page(s) | 0 Won |
| [Claiming Priority] | 0 case(s) | 0 Won |
| [Examination Fee] | 0 claim(s) | 0 Won |
| [Total] | | 29,000 Won |

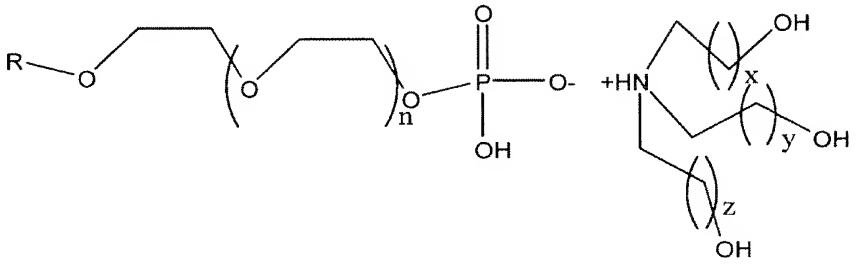
**[Attached Document]** 1. Abstract and Specification (Drawings)_1 copy

## [ABSTRACT]

### [ABSTRACT OF THE DISCLOSURE]

A cleaning solution for photoresist and a method for forming a pattern using the same are useful for cleaning a semiconductor substrate in the last step of development when photoresist patterns are formed. The cleaning solution comprises $H_2O$ as a main component, a surfactant which is phosphate-alcoholamine salt represented by Formula 1, and an alcohol compound as additives. The cleaning solution has a lower surface tension than that of distilled water which has been used for conventional cleaning solutions, thereby improving resistance to photoresist pattern collapse and stabilizing the photoresist pattern formation.

[Formula 1]




wherein R, x, y, z and n are as defined in the specification.

**[Representative Figure]** Fig. 1

## [SPECIFICATION]

### [TITLE OF THE INVENTION]

CLEANING SOLUTION FOR PHOTORESIST AND METHOD FOR FORMING PATTERN USING THE SAME

### [BRIEF DESCRIPTION OF THE DRAWINGS]

Fig. 1 is a photograph of a photoresist pattern obtained from Example 5.

Fig. 2 is a photograph of a photoresist pattern obtained from Example 6.

Fig. 3 is a photograph of a photoresist pattern obtained from Example 7.

Fig. 4 is a photograph of a photoresist pattern obtained from Example 8.

Fig. 5 is a photograph of a photoresist pattern obtained from Comparative Example 2.

**[DETAILED DESCRIPTION OF THE INVENTION]**

**[OBJECTS OF THE INVENTION]**

**[FIELD OF THE INVENTION AND BACKGROUND ARTS]**

The present invention generally relates to a cleaning solution for photoresist which is useful for cleaning a semiconductor substrate in the last step of development when photoresist patterns are formed. More specifically, the present invention relates to a cleaning solution that comprises $H_2O$ as a main component, a surfactant which is phosphate-alcoholamine salt represented by Formula 1 and an alcohol compound as additives, and a method for forming a pattern using the same.

As semiconductor devices become smaller, the aspect ratio of the photoresist patterns (i.e. the ratio of the thickness of photoresist, or height to the linewidth of formed pattern) increases. As a result, patterns are collapsed in the cleaning process.

When the height of formed photoresist patterns extends beyond the critical height, capillary force exceeds elasticity of photoresist. In order to overcome this excess phenomenon, adhesive force between underlying layers and photoresist is enhanced by increasing inner elasticity of photoresist or decreasing surface tension thereof.

Generally, a method of forming photoresist patterns on semiconductor substrates comprises the steps of: forming an underlying layer over a semiconductor substrate; forming a photoresist film over the underlying layer; and exposing a portion of the underlying layer by exposing and developing processes to form a photoresist pattern. In case of a positive photoresist, the photoresist film of an exposing region is removed by developing solution to form a photoresist pattern.

The last step of the above method is a cleaning process of removing the residual photoresist film by spraying distilled water from spin equipment while spinning the semiconductor substrate. In this process, the pattern

is collapsed due to high surface tension of the distilled water.

Conventionally, U.S. Patent No. 5,374,502 discloses a method for preventing the collapse of photoresist patterns having high aspect ratios with a cleaning solution including tert-amyl alcohol, 2-methyl-1-butanol, 1-butanol, tert-butyl alcohol, 3-pentanol and isobutyl alcohol.

In addition, U.S. Patent No. 5,474,877 discloses a method for preventing the collapse of photoresist patterns with a cleaning solution whose surface tension is lowered by heat.

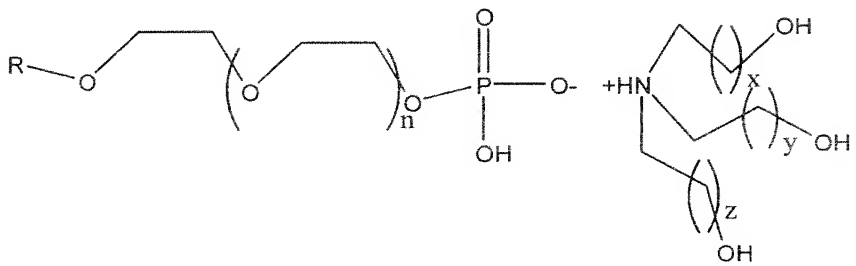
**[TECHNICAL SUBJECT OF THE INVENTION]**

Various embodiments of the present invention are directed at providing a cleaning solution for photoresist having a lower surface tension to prevent the collapse of photoresist patterns in a cleaning process for residual photoresists in the last step of the developing process, and a method for forming a pattern using the same.

**[CONFIGURATION OF THE INVENTION]**

A cleaning solution for photoresist comprises $H_2O$ as a main component and a surfactant which is a phosphate-alcoholamine salt represented by Formula 1 as an additive:

[Formula 1]




wherein

R is $C_8$-$C_{20}$ alkyl or $C_3$-$C_{20}$ aromatic ring;

x, y and z individually are an integer ranging from 0 to 10; and

n is an integer ranging from 3 to 50.

In the compound of Formula 1, R is selected from the group consisting of octyl, octyl phenyl, nonyl, nonyl phenyl, decyl, decyl phenyl, undecyl, undecyl phenyl, dodoecyl and dodecyl phenyl, and n is an integer ranging from 5 to 10.

More specifically, the compound of Formula 1 is selected from the group consisting of compound wherein R is nonyl, x, y and z are 1, and n is 7; compound wherein R is octyl, x, y and z are 1, and n is 7; compound wherein R is dodecyl, x, y and z are 0, and n is 7; and compound wherein R is octyl phenyl, x, y and z are 1, and n is 3.

The compound of Formula 1 is water-soluble since the compound is salt. Also, the compound of Formula 1, which includes both a hydrophilic group such as a hydroxyl group and a hydrophobic group such as an alkyl group having a long chain in one molecule, remarkably lowers surface tension.

The water of the disclosed cleaning solution is preferably distilled water.

The cleaning solution for photoresist further comprises an alcohol compound.

The above alcohol comprises $C_1$-$C_{10}$ alkyl alcohol or $C_1$-$C_{10}$ alkoxy alcohol. Preferably, the $C_1$-$C_{10}$ alkyl alcohol is selected from the group consisting of methanol, ethanol, propanol, isopropanol, n-butanol, sec-butanol, t-butanol, 1-pentanol, 2-pentanol, 3-pentanol, 2,2-dimethyl-1-propanol and mixtures thereof, and the $C_1$-$C_{10}$ alkoxyalkyl alcohol is selected from the group consisting of 2-methoxyethanol, 2-(2-methoxyethoxy)ethanol, 1-methoxy-2-propanol, 3-methoxy-1,2-propandiol and mixtures thereof.

In the cleaning solution, the compound of Formula 1, which is a surfactant, is present in an amount ranging from 0.001 to 2 wt%, preferably from 0.01 to 1 wt%, based on the total weight of the solution, and the alcohol compound is

present in an amount ranging from 0 to 20 wt%, preferably from 0.01 to 10 wt%, based on the total weight of said solution.

When the compound of Formula 1 is present in the amount of less than 0.001 wt%, the effect of lowering surface tension is degraded. When the compound of Formula 1 is present in the amount of more than 2 wt%, the effect of lowering surface tension is also degraded in comparison with the added amount, and the residual compound of Formula 1 remains on the wafer.

In addition, when the alcohol is present in the amount of more than 20 wt%, the alcohol dissolves photoresist materials, thereby collapsing patterns.

The cleaning solution is manufactured by filtering the resulting mixture of the distilled water, the compound of Formula 1 and the alcohol with 0.2μm filter.

A method for forming a photoresist pattern by a wet-developing process comprises:

(a) coating a common photoresist over an underlying layer of a semiconductor substrate to form a photoresist film;

(b) exposing the photoresist film to light;

(c) developing the exposed photoresist film with a developing solution; and

(d) cleaning the resulting structure using a cleaning solution according to an embodiment of the present invention.

The above method further comprises a soft baking step before the step (b) or a post baking step after the step (b). Preferably, the bake process is performed at a temperature ranging from 70 to 200°C.

In the above the exposure step, the light source is preferably selected from the group consisting of KrF (248 nm), ArF (193 nm), VUV (157 nm), EUV (13 nm), E-beam, X-ray

and ion-beam. The exposure step is preferably performed at exposure energy ranging from 0.1 to 50 $mJ/cm^2$.

The above developing step (c) is performed with an alkaline developing solution which is preferably TMAH aqueous solution ranging from 0.01 to 5 wt%.

As described above, the cleaning process is performed with the cleaning solution including the compound of Formula 1 which is a surfactant in the last step of the developing process to lower the surface tension of the cleaning solution, thereby preventing the collapse of patterns in the developing process when photoresist patterns are formed.

Additionally, a semiconductor device manufactured according to the above-described process is provided.

The cleaning solution for photoresist will be described in more details referring to examples below, when are not intended to be limiting.

Example 1. Preparation of Cleaning Solution and Measurement of Surface Tension (1)

The compound (0.3 g) of Formula 1 wherein R is nonyl, x, y and z are 1, and n is 7, methanol (1 g) and distilled water (99 g) were stirred for 1 minute. The resulting mixture was filtered through a 0.2μm filter to obtain a cleaning solution according to an embodiment of the present invention. The surface tension of the cleaning solution measured by a KRUSS K9 tension meter of measurement equipment was $31Nm/m^2$.

Example 2. Preparation of Cleaning Solution and Measurement of Surface Tension (2)

The compound (0.3 g) of Formula 1 wherein R is octyl, x, y and z are 1, and n is 7, methanol (1 g) and distilled water (99 g) were stirred for 1 minute. The resulting mixture was filtered through a 0.2 μm filter to obtain a cleaning solution according to an embodiment of the present invention. The surface tension of the cleaning solution measured by a KRUSS K9 was $32Nm/m^2$.

Example 3. Preparation of Cleaning Solution and Measurement of Surface Tension (3)

The compound (0.3 g) of Formula 1 wherein R is dodecyl, x, y and z are 0, and n is 7, isopropanol (1 g) and distilled water (99 g) were stirred for 1 minute. The resulting mixture was filtered through a 0.2 μm filter to obtain a cleaning solution according to an embodiment of the present invention. The surface tension of the cleaning solution measured by a KRUSS K9 was 28Nm/$m^2$.

Example 4. Preparation of Cleaning Solution and Measurement of Surface Tension (4)

The compound (0.3 g) of Formula 1 wherein R is octyl phenyl, x, y and z are 1, and n is 3, isopropanol (1 g) and distilled water (99 g) were stirred for 1 minute. The resulting mixture was filtered through a 0.2 μm filter to obtain a cleaning solution according to an embodiment of the present ivnention. The surface tension of the cleaning solution measured by a KRUSS K9 was 29Nm/$m^2$.

Comparative Example 1. Measurement of Surface Tension of Distilled Water (5)

The surface tension of the distilled water as measured by the KRUSS K9 was 73N m/$m^2$.

Example 5. Formation of Photoresist Pattern (1)

After an underlying layer was formed on a silicon wafer treated with hexamethyldisilazane (HMDS), a photoresist comprising methacrylate type compound, sold under the designation "AX1020P" by Clariant, was spin-coated on the silicon wafer at a thickness 2400 Å to form a photoresist film, and soft-backed at 130°C for 90 seconds. After soft-baking, the photoresist film was exposed to light using an ArF laser exposer, and then post-baked at 130°C for 90 seconds. When the post-baking was completed, it was developed in 2.38 wt% aqueous TMAH solution for 30 seconds. While the silicon wafer was spun, the silicon wafer was cleaned by spraying the cleaning solution (30 ml) obtained

from Example 1 from the spin equipment and then dehydrated, to obtain 90 nm L/S photoresist pattern (see Fig. 1).

Example 6. Formation of Photoresist Pattern (2)

The procedure of Example 1 was repeated using the cleaning solution of Example 2 instead of the cleaning solution of Example 1 to obtain 90 nm L/S photoresist pattern (see Fig. 2).

Example 7. Formation of Photoresist Pattern (3)

The procedure of Example 1 was repeated using the cleaning solution of Example 3 instead of the cleaning solution of Example 1 to obtain 90 nm L/S photoresist pattern (see Fig. 3).

Example 8. Formation of Photoresist Pattern (4)

The procedure of Example 1 was repeated using the cleaning solution of Example 4 instead of the cleaning solution of Example 1 to obtain 90 nm L/S photoresist pattern (see Fig. 4).

Comparative Example 2. Formation of Photoresist Pattern (5)

The procedure of Example 1 was repeated using the distilled water instead of the cleaning solution of Example 1 to obtain a photoresist pattern. As a result, the photoresist pattern was collapsed (see Fig. 5).

**[EFFECT OF THE INVENTION]**

As described above, a cleaning solution according to an embodiment of the present invention is used for cleaning a semiconductor substrate in the last step of the development when photoresist patterns are formed. As a result, the collapse of patterns can be avoided because the cleaning solution has a lower surface tension than that of distilled water which has been used in conventional cleaning solutions. Accordingly, the cleaning solution may enable

stabilization of development processes for forming ultrafine photoresist patterns of less than 130 nm.

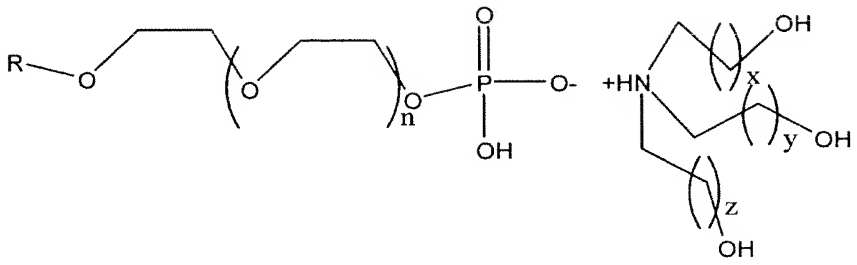
**WHAT IS CLAIMED IS:**

1. A cleaning solution for photoresist patterns comprising:

$H_2O$ as a main component; and

a compound represented by Formula 1 as a surfactant:

Formula 1




wherein

R is $C_8$-$C_{20}$ alkyl or $C_3$-$C_{20}$ aromatic ring;

x, y and z individually are an integer ranging from 0 to 10; and

n is an integer ranging from 3 to 50.

2. The cleaning solution according to claim 1, further comprising an alcohol compound.

3. The cleaning solution according to claim 1 or 2, wherein the surfactant is present in an amount ranging from 0.001 to 2 wt%, and the alcohol compound is present in an amount ranging from 0 to 20 wt%, based on the total weight of the solution.

4. The cleaning solution according to claim 3, wherein the surfactant is present in an amount ranging from 0.01 to 1 wt%, and the alcohol compound is present in an

amount ranging from 0.01 to 10 wt%, based on the total weight of the solution.

5. The cleaning solution according to claim 1, wherein R is selected from the group consisting of octyl, octyl phenyl, nonyl, nonyl phenyl, decyl, decyl phenyl, undecyl, undecyl phenyl, dodoecyl and dodecyl phenyl, and n is an integer ranging from 5 to 10.

6. The cleaning solution according to claim 2, wherein the alcohol is selected from the group consisting of $C_1$-$C_{10}$ alkyl alcohol, $C_1$-$C_{10}$ alkoxy alcohol, and mixtures thereof.

7. The cleaning solution according to claim 6, wherein the $C_1$-$C_{10}$ alkyl alcohol is selected from the group consisting of methanol, ethanol, propanol, isopropanol, n-butanol, sec-butanol, t-butanol, 1-pentanol, 2-pentanol, 3-pentanol, 2,2-dimethyl-1-propanol and mixtures thereof.

8. The cleaning solution according to claim 6, wherein the $C_1$-$C_{10}$ alkoxy alcohol is selected from the group consisting of 2-methoxyethanol, 2-(2-methoxyethoxy)ethanol, 1-methoxy-2-propanol, 3-methoxy-1,2-propandiol and mixtures thereof.

9. The cleaning solution according to claim 1, wherein the solution is selected from the group consisting of

mixture comprising the compound of Formula 1 as a surfactant wherein R is nonyl; x, y and z are 1, respectively; and n is 7, methanol as an alcohol and water as a solvent;

mixture comprising the compound of Formula 1 as a surfactant wherein R is octyl; x, y and z are 1, respectively; and n is 7, methanol as an alcohol and water as a solvent;

mixture comprising the compound of Formula 1 as a surfactant wherein R is dodecyl; x, y and z are 0, respectively; and n is 7, isopropanol as an alcohol and water as a solvent; and

mixture comprising the compound of Formula 1 as a surfactant wherein R is octyl phenyl; x, y and z are 1, respectively; and n is 3, isopropanol as an alcohol and water as a solvent.

10. A method for forming a photoresist pattern, comprising:

(a) coating a common photoresist over an underlying layer of a semiconductor substrate to form a photoresist film;

(b) exposing the photoresist film to light;

(c) developing the exposed photoresist film with a developing solution; and

(d) cleaning the resulting structure using a cleaning solution of claim 1.

11. The method according to claim 10, further comprising soft baking step before the step (b) or post baking step after the step (b).

12. The method according to claim 10, wherein the source of the light is selected from the group consisting of KrF (248 nm), ArF (193 nm), VUV (157 nm), EUV (13 nm), E-beam, X-ray and ion-beam.

13. A semiconductor device manufactured by the method of claim 10.

## APPENDIX B

A verified English-language translation of Korean patent application No. 2003-22273 filed April 9, 2003.

**STATUTORY DECLARATION**

I, Hyun Soon KIM, a citizen of the Republic of Korea and a staff member of Bae, Kim & Lee IP Group, do hereby declare that:

1) I am conversant with the English and Korean languages and am a competent translator thereof;

2) To the best of my knowledge and belief, the following is a true and correct translation of the Priority Document (KR Patent Application No. 10-2003-0022273) filed on April 9, 2003.

Signed this 18th day of December 2006

김 현 순

Hyun Soon KIM

# KOREAN INTELLECTUAL PROPERTY OFFICE

This is to certify that the following application annexed hereto is a true copy from the records of the Korean Intellectual Property Office.

**Application Number: 10-2003-0022273**

**Date of Application: April 9, 2003**

**Applicant(s): Hynix Semiconductor Inc.**

**Dated October 6, 2003**

COMMISSIONER

**[Document Name]** Patent Application

**[Claim Division]** Patent

**[To]** The Commissioner of Korean Intellectual Property Office

**[Filing Date]** April 9, 2003

**[International Patent Classification]** H01L

**[Title of Invention]** Cleaning Solution for Photoresist and Method for Forming Pattern Using the Same

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**[Purport]** We file an application pursuant to Article 42 of the Korean Patent Law.

Patent Attorney Eui In HWANG

Patent Attorney Jung Hoon LEE

**[Official Fee]**

| | | |
|---|---|---|
| [Basic Fee] | 17 page(s) | 29,000 Won |
| [Additional Fee] | 0 page(s) | 0 Won |
| [Claiming Priority] | 0 case(s) | 0 Won |
| [Examination Fee] | 0 claim(s) | 0 Won |
| [Total] | | 29,000 Won |

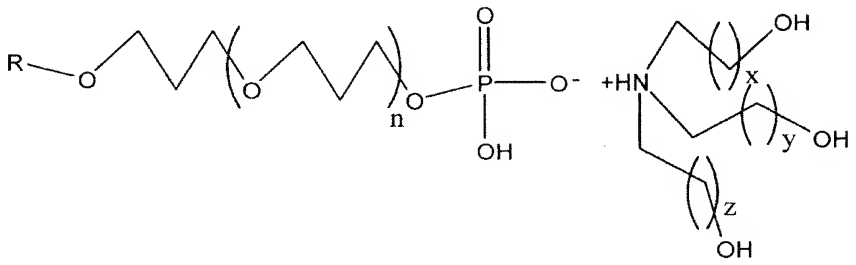
**[Attached Document]** 1. Abstract and Specification (Drawings)_1 copy

## [ABSTRACT]

### [ABSTRACT OF THE DISCLOSURE]

A cleaning solution for photoresist and a method for forming a pattern using the same are useful for cleaning a semiconductor substrate in the last step of development when photoresist patterns are formed. The cleaning solution comprises $H_2O$ as a main component, a surfactant which is phosphoricester-alcoholamine salt represented by Formula 1, and an alcohol compound as additives. The cleaning solution has a lower surface tension than that of distilled water which has been used for conventional cleaning solutions, thereby improving resistance to photoresist pattern collapse and stabilizing the photoresist pattern formation.

[Formula 1]




wherein R, x, y, z and n are as defined in the specification.

**[Representative Figure]** Fig. 1

## [SPECIFICATION]

**[TITLE OF THE INVENTION]**

CLEANING SOLUTION FOR PHOTORESIST AND METHOD FOR FORMING PATTERN USING THE SAME

**[BRIEF DESCRIPTION OF THE DRAWINGS]**

Fig. 1 is a photograph of a photoresist pattern obtained from Example 5.

Fig. 2 is a photograph of a photoresist pattern obtained from Example 6.

Fig. 3 is a photograph of a photoresist pattern obtained from Example 7.

Fig. 4 is a photograph of a photoresist pattern obtained from Example 8.

Fig. 5 is a photograph of a photoresist pattern obtained from Comparative Example 2.

**[DETAILED DESCRIPTION OF THE INVENTION]**

**[OBJECTS OF THE INVENTION]**

**[FIELD OF THE INVENTION AND BACKGROUND ARTS]**

The present invention generally relates to a cleaning solution for photoresist which is useful for cleaning a semiconductor substrate in the last step of development when photoresist patterns are formed. More specifically, the present invention relates to a cleaning solution that comprises $H_2O$ as a main component, a surfactant which is phosphoricester-alcoholamine salt represented by Formula 1 and an alcohol compound as additives, and a method for forming a pattern using the same.

As semiconductor devices become smaller, the aspect ratio of the photoresist patterns (i.e. the ratio of the thickness of photoresist, or height to the linewidth of formed pattern) increases. As a result, patterns are collapsed in the cleaning process.

When the height of formed photoresist patterns extends beyond the critical height, capillary force exceeds elasticity of photoresist. In order to overcome this excess phenomenon, adhesive force between underlying layers and photoresist is enhanced by increasing inner elasticity of photoresist or decreasing surface tension thereof.

Generally, a method of forming photoresist patterns on semiconductor substrates comprises the steps of: forming an underlying layer over a semiconductor substrate; forming a photoresist film over the underlying layer; and exposing a portion of the underlying layer by exposing and developing processes to form a photoresist pattern. In case of a positive photoresist, the photoresist film of an exposing region is removed by developing solution to form a photoresist pattern.

The last step of the above method is a cleaning process of removing the residual photoresist film by spraying distilled water from spin equipment while spinning the semiconductor substrate. In this process, the pattern

is collapsed due to high surface tension of the distilled water.

Conventionally, U.S. Patent No. 5,374,502 discloses a method for preventing the collapse of photoresist patterns having high aspect ratios with a cleaning solution including tert-amyl alcohol, 2-methyl-1-butanol, 1-butanol, tert-butyl alcohol, 3-pentanol and isobutyl alcohol.

In addition, U.S. Patent No. 5,474,877 discloses a method for preventing the collapse of photoresist patterns with a cleaning solution whose surface tension is lowered by heat.

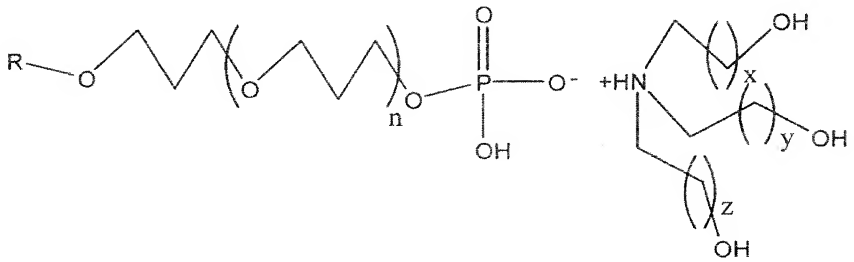
**[TECHNICAL SUBJECT OF THE INVENTION]**

Various embodiments of the present invention are directed at providing a cleaning solution for photoresist having a lower surface tension to prevent the collapse of photoresist patterns in a cleaning process for residual photoresists in the last step of the developing process, and a method for forming a pattern using the same.

**[CONFIGURATION OF THE INVENTION]**

A cleaning solution for photoresist comprises $H_2O$ as a main component and a surfactant which is a phosphericester-alcoholamine salt represented by Formula 1 as an additive:

[Formula 1]




wherein

R is $C_8$-$C_{20}$ alkyl or $C_3$-$C_{10}$ aromatic ring;

x, y and z individually are an integer ranging from 0 to 10; and

n is an integer ranging from 3 to 50.

In the compound of Formula 1, R is selected from the group consisting of octyl, octyl phenyl, nonyl, nonyl phenyl, decyl, decyl phenyl, undecyl, undecyl phenyl, dodoecyl and dodecyl phenyl, and n is an integer ranging from 5 to 10.

More specifically, the compound of Formula 1 is selected from the group consisting of compound wherein R is nonyl, x, y and z are 1, and n is 7; compound wherein R is octyl, x, y and z are 1, and n is 7; compound wherein R is dodecyl, x, y and z are 0, and n is 7; and compound wherein R is octyl phenyl, x, y and z are 1, and n is 3.

The compound of Formula 1 is water-soluble since the compound is salt. Also, the compound of Formula 1, which includes both a hydrophilic group such as a hydroxyl group and a hydrophobic group such as an alkyl group having a long chain in one molecule, remarkably lowers surface tension.

The water of the disclosed cleaning solution is preferably distilled water.

The cleaning solution for photoresist further comprises an alcohol compound.

The above alcohol comprises $C_1$-$C_{10}$ alkyl alcohol or $C_1$-$C_{10}$ alkoxy alcohol. Preferably, the $C_1$-$C_{10}$ alkyl alcohol is selected from the group consisting of methanol, ethanol, propanol, isopropanol, n-butanol, sec-butanol, t-butanol, 1-pentanol, 2-pentanol, 3-pentanol, 2,2-dimethyl-1-propanol and mixtures thereof, and the $C_1$-$C_{10}$ alkoxyalkyl alcohol is selected from the group consisting of 2-methoxyethanol, 2-(2-methoxyethoxy)ethanol, 1-methoxy-2-propanol, 3-methoxy-1,2-propandiol and mixtures thereof.

In the cleaning solution, the compound of Formula 1, which is a surfactant, is present in an amount ranging from 0.001 to 2 wt%, preferably from 0.001 to 1 wt%, based on the total weight of the solution, and the alcohol compound is

present in an amount ranging from 0 to 10 wt%, preferably from 0.001 to 5 wt%, based on the total weight of said solution.

When the compound of Formula 1 is present in the amount of less than 0.001 wt%, the effect of lowering surface tension is degraded. When the compound of Formula 1 is present in the amount of more than 2 wt%, the effect of lowering surface tension is also degraded in comparison with the added amount, and the residual compound of Formula 1 remains on the wafer.

In addition, when the alcohol is present in the amount of more than 10 wt%, the alcohol dissolves photoresist materials, thereby collapsing patterns.

The disclosed cleaning solution is manufactured by filtering the resulting mixture of the distilled water, the compound of Formula 1 and the alcohol with 0.2μm filter.

A method for forming a photoresist pattern by a wet-developing process comprises:

(a) coating a common photoresist over an underlying layer of a semiconductor substrate to form a photoresist film;

(b) exposing the photoresist film to light;

(c) developing the exposed photoresist film with a developing solution; and

(d) cleaning the resulting structure using a cleaning solution according to an embodiment of the present invention.

The above method further comprises a soft baking step before the step (b) or a post baking step after the step (b). Preferably, the bake process is performed at a temperature ranging from 70 to 200°C.

In the above the exposure step, the light source is preferably selected from the group consisting of KrF (248 nm), ArF (193 nm), VUV (157 nm), EUV (13 nm), E-beam, X-ray

and ion-beam. The exposure step is preferably performed at exposure energy ranging from 0.1 to 50 $mJ/cm^2$.

The above developing step (c) is performed with an alkaline developing solution which is preferably TMAH aqueous solution ranging from 0.01 to 5 wt%.

As described above, the cleaning process is performed with the cleaning solution including the compound of Formula 1 which is a surfactant in the last step of the developing process to lower the surface tension of the cleaning solution, thereby preventing the collapse of patterns in the developing process when photoresist patterns are formed.

Additionally, a semiconductor device manufactured according to the above-described process is provided.

The cleaning solution for photoresist will be described in more details referring to examples below, when are not intended to be limiting.

Example 1. Preparation of Cleaning Solution and Measurement of Surface Tension (1)

The compound (0.3 g) of Formula 1 wherein R is nonyl, x, y and z are 1, and n is 7, methanol (1 g) and distilled water (99 g) were stirred for 1 minute. The resulting mixture was filtered through a 0.2μm filter to obtain a cleaning solution according to an embodiment of the present invention. The surface tension of the cleaning solution measured by a KRUSS K9 tension meter of measurement equipment was $34Nm/m^2$.

Example 2. Preparation of Cleaning Solution and Measurement of Surface Tension (2)

The compound (0.3 g) of Formula 1 wherein R is octyl, x, y and z are 1, and n is 7, methanol (1 g) and distilled water (99 g) were stirred for 1 minute. The resulting mixture was filtered through a 0.2 μm filter to obtain a cleaning solution according to an embodiment of the present invention. The surface tension of the cleaning solution measured by a KRUSS K9 was $37Nm/m^2$.

Example 3. Preparation of Cleaning Solution and Measurement of Surface Tension (3)

The compound (0.3 g) of Formula 1 wherein R is dodecyl, x, y and z are 0, and n is 7, isopropanol (1 g) and distilled water (99 g) were stirred for 1 minute. The resulting mixture was filtered through a 0.2 μm filter to obtain a cleaning solution according to an embodiment of the present invention. The surface tension of the cleaning solution measured by a KRUSS K9 was 33Nm/$m^2$.

Example 4. Preparation of Cleaning Solution and Measurement of Surface Tension (4)

The compound (0.3 g) of Formula 1 wherein R is octyl phenyl, x, y and z are 1, and n is 3, isopropanol (1 g) and distilled water (99 g) were stirred for 1 minute. The resulting mixture was filtered through a 0.2 μm filter to obtain a cleaning solution according to an embodiment of the present ivnention. The surface tension of the cleaning solution measured by a KRUSS K9 was 37Nm/$m^2$.

Comparative Example 1. Measurement of Surface Tension of Distilled Water

The surface tension of the distilled water as measured by the KRUSS K9 was 73N m/$m^2$.

Example 5. Formation of Photoresist Pattern (1)

After an underlying layer was formed on a silicon wafer treated with hexamethyldisilazane (HMDS), a photoresist comprising methacrylate type compound, sold under the designation "AX1020P" by Clariant, was spin-coated on the silicon wafer at a thickness 2400 Å to form a photoresist film, and soft-backed at 130°C for 90 seconds. After soft-baking, the photoresist film was exposed to light using an ArF laser exposer, and then post-baked at 130°C for 90 seconds. When the post-baking was completed, it was developed in 2.38 wt% aqueous TMAH solution for 30 seconds. While the silicon wafer was spun, the silicon wafer was cleaned by spraying the cleaning solution (30 ml) obtained

from Example 1 from the spin equipment and then dehydrated, to obtain 90 nm L/S photoresist pattern (see Fig. 1).

Example 6. Formation of Photoresist Pattern (2)

The procedure of Example 1 was repeated using the cleaning solution of Example 2 instead of the cleaning solution of Example 1 to obtain 90 nm L/S photoresist pattern (see Fig. 2).

Example 7. Formation of Photoresist Pattern (3)

The procedure of Example 1 was repeated using the cleaning solution of Example 3 instead of the cleaning solution of Example 1 to obtain 90 nm L/S photoresist pattern (see Fig. 3).

Example 8. Formation of Photoresist Pattern (4)

The procedure of Example 1 was repeated using the cleaning solution of Example 4 instead of the cleaning solution of Example 1 to obtain 90 nm L/S photoresist pattern (see Fig. 4).

Comparative Example 2. Formation of Photoresist Pattern (5)

The procedure of Example 1 was repeated using the distilled water instead of the cleaning solution of Example 1 to obtain a photoresist pattern. As a result, the photoresist pattern was collapsed (see Fig. 5).

**[EFFECT OF THE INVENTION]**

As described above, a cleaning solution according to an embodiment of the present invention is used for cleaning a semiconductor substrate in the last step of the development when photoresist patterns are formed. As a result, the collapse of patterns can be avoided because the cleaning solution has a lower surface tension than that of distilled water which has been used in conventional cleaning solutions. Accordingly, the cleaning solution may enable

stabilization of development processes for forming ultrafine photoresist patterns of less than 130 nm.

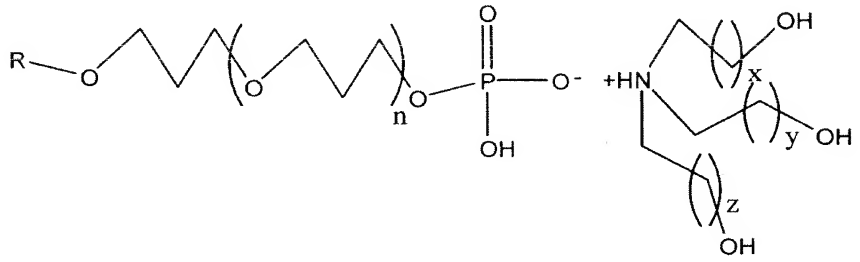
**WHAT IS CLAIMED IS:**

1. A cleaning solution for photoresist patterns comprising:

$H_2O$ as a main component; and

a compound represented by Formula 1 as a surfactant:

Formula 1




wherein

R is $C_8$-$C_{20}$ alkyl or $C_3$-$C_{10}$ aromatic ring;

x, y and z individually are an integer ranging from 0 to 10; and

n is an integer ranging from 3 to 50.

2. The cleaning solution according to claim 1, further comprising an alcohol compound.

3. The cleaning solution according to claim 1 or 2, wherein the surfactant is present in an amount ranging from 0.001 to 2 wt%, and the alcohol compound is present in an amount ranging from 0 to 10 wt%, based on the total weight of the solution.

4. The cleaning solution according to claim 3, wherein the surfactant is present in an amount ranging from 0.001 to 1 wt%, and the alcohol compound is present in an amount ranging from 0.001 to 5 wt%, based on the total weight of the solution.

5. The cleaning solution according to claim 1, wherein R is selected from the group consisting of octyl, octyl phenyl, nonyl, nonyl phenyl, decyl, decyl phenyl, undecyl, undecyl phenyl, dodoecyl and dodecyl phenyl, and n is an integer ranging from 5 to 10.

6. The cleaning solution according to claim 2, wherein the alcohol is selected from the group consisting of $C_1$-$C_{10}$ alkyl alcohol, $C_1$-$C_{10}$ alkoxy alcohol, and mixtures thereof.

7. The cleaning solution according to claim 6, wherein the $C_1$-$C_{10}$ alkyl alcohol is selected from the group consisting of methanol, ethanol, propanol, isopropanol, n-butanol, sec-butanol, t-butanol, 1-pentanol, 2-pentanol, 3-pentanol, 2,2-dimethyl-1-propanol and mixtures thereof.

8. The cleaning solution according to claim 6, wherein the $C_1$-$C_{10}$ alkoxy alcohol is selected from the group consisting of 2-methoxyethanol, 2-(2-methoxyethoxy)ethanol, 1-methoxy-2-propanol, 3-methoxy-1,2-propandiol and mixtures thereof.

9. The cleaning solution according to claim 1, wherein the solution is selected from the group consisting of

mixture comprising the compound of Formula 1 as a surfactant wherein R is nonyl; x, y and z are 1, respectively; and n is 7, methanol as an alcohol and water as a solvent;

mixture comprising the compound of Formula 1 as a surfactant wherein R is octyl; x, y and z are 1,

respectively; and n is 7, methanol as an alcohol and water as a solvent;

mixture comprising the compound of Formula 1 as a surfactant wherein R is dodecyl; x, y and z are 0, respectively; and n is 7, isopropanol as an alcohol and water as a solvent; and

mixture comprising the compound of Formula 1 as a surfactant wherein R is octyl phenyl; x, y and z are 1, respectively; and n is 3, isopropanol as an alcohol and water as a solvent.

10. A method for forming a photoresist pattern, comprising:

(a) coating a common photoresist over an underlying layer of a semiconductor substrate to form a photoresist film;

(b) exposing the photoresist film to light;

(c) developing the exposed photoresist film with a developing solution; and

(d) cleaning the resulting structure using a cleaning solution of claim 1.

11. The method according to claim 10, further comprising soft baking step before the step (b) or post baking step after the step (b).

12. The method according to claim 10, wherein the source of the light is selected from the group consisting of KrF (248 nm), ArF (193 nm), VUV (157 nm), EUV (13 nm), E-beam, X-ray and ion-beam.

13. A semiconductor device manufactured by the method of claim 10.